



Symbolization



GEOG482 SP2020

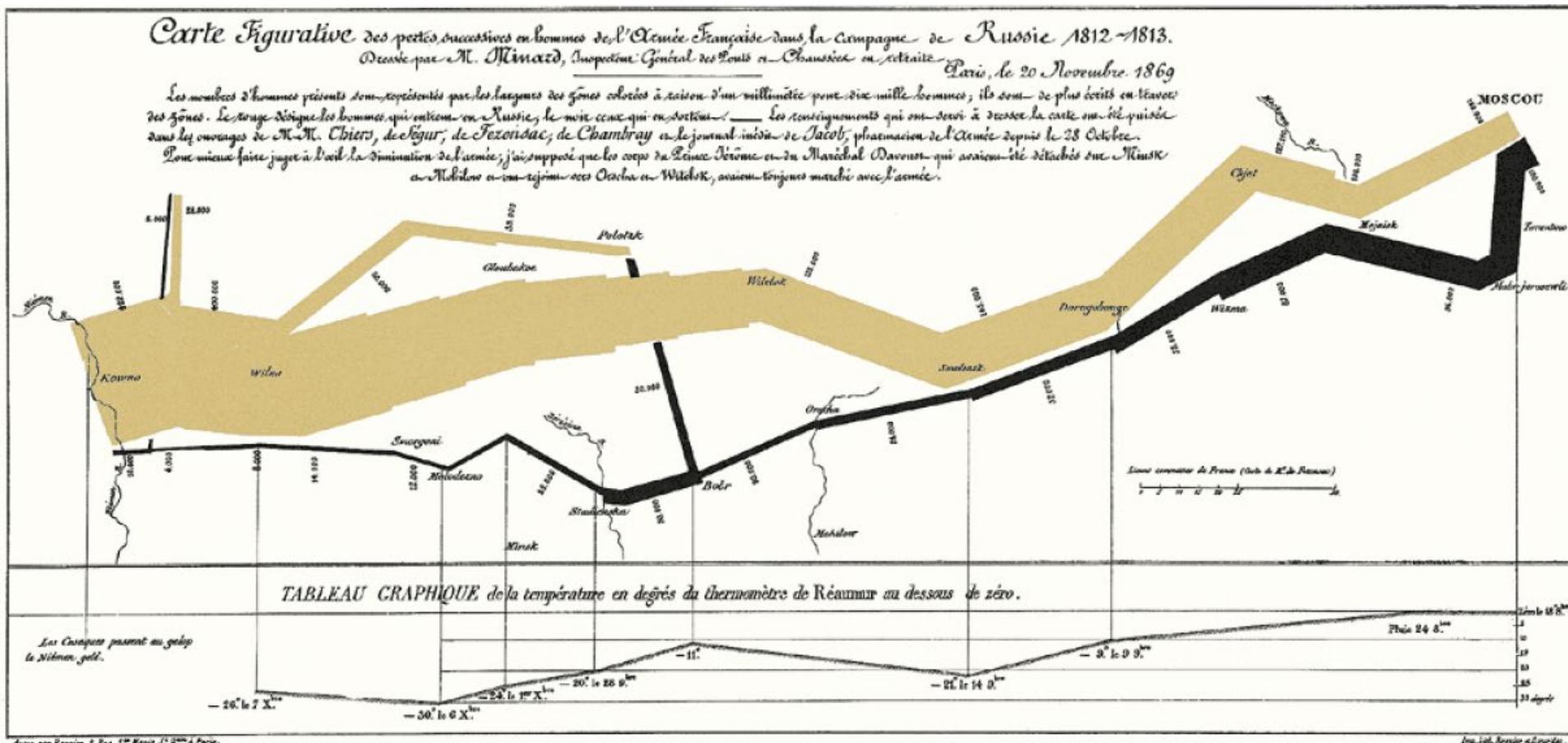
Outline

- ▶ The nature of geographic phenomena, representation, and symbolization
 - ▶ How we **think** about phenomena
 - ▶ Discrete vs. continuous
 - ▶ How we **sample** phenomena
 - ▶ Random, systematic, census
 - ▶ How we **measure** phenomena
 - ▶ Nominal, Ordinal, Interval, Ratio measurements
 - ▶ How we **represent** phenomena
 - ▶ Points, lines, areas, volumes
 - ▶ How we **symbolize** phenomena
 - ▶ Visual variables



Matching phenomena, data, and visual variables

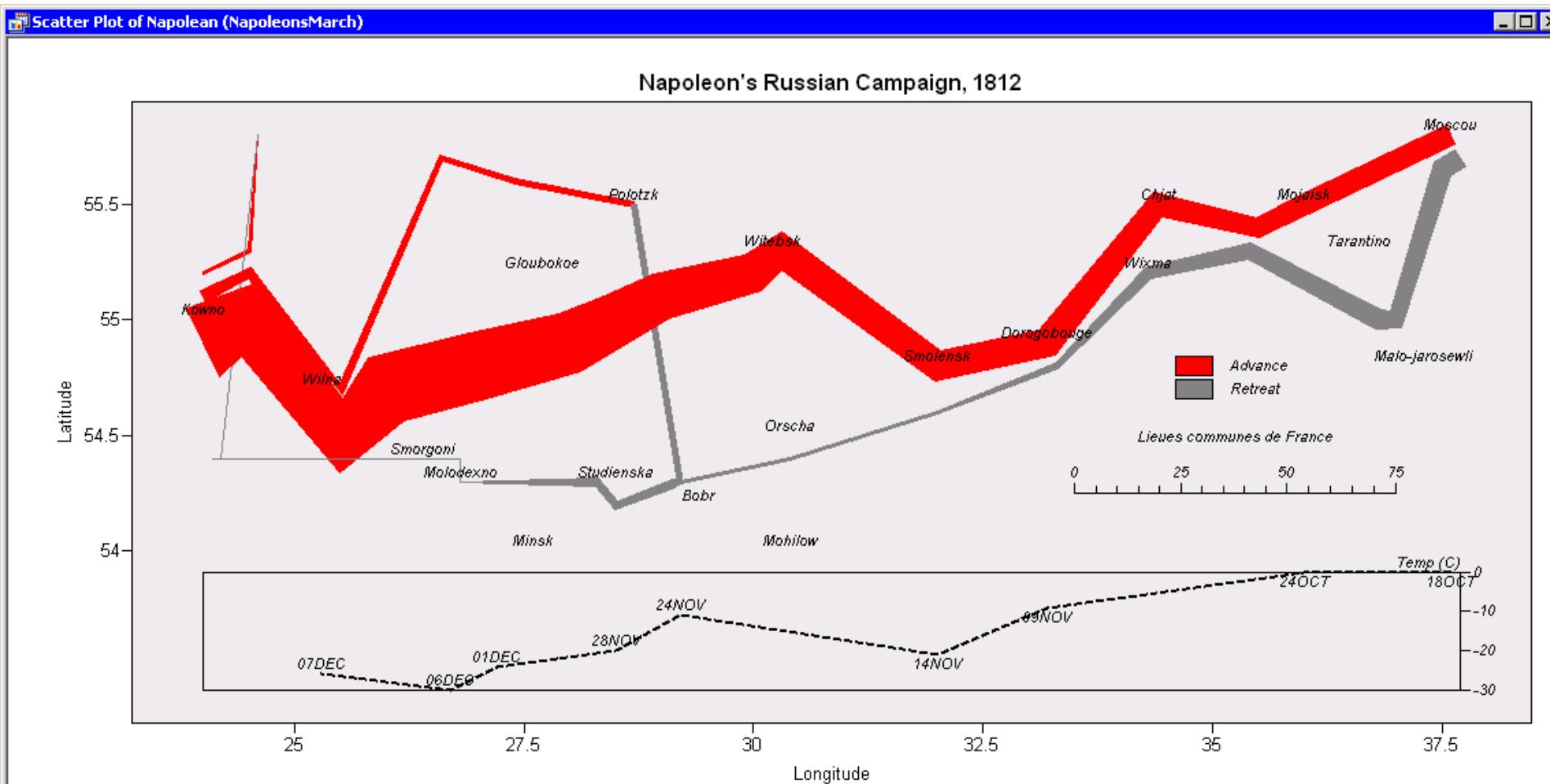
- ▶ C.J. Minard (1861). Mapping Napoleon's March in 1812



▶ “...the single best-known statistical graphic of the nineteenth century, hailed today by statisticians, geographers, historians and the like...” (John Corbett)

Source: <http://www.csiss.org/classics/content/58>

Scatterplot of the Napoleon's March (how many variables?)



► (image source: <http://www.math.yorku.ca/SCS/Gallery/minard/Minard-IML.gif>)

Group Activity: More variations

- ▶ Make 4 groups of 3-5 people
- ▶ Choose one of the variations in the link below and discuss advantages of the representation (3min.)
 - ▶ <https://www.esri.com/about/newsroom/insider/catching-up-with-time/>
- ▶ Share your group's thoughts



Base-map compilation

: how do we start to make maps?

- ▶ Digitization
- ▶ Data generalization
- ▶ Using external data sources



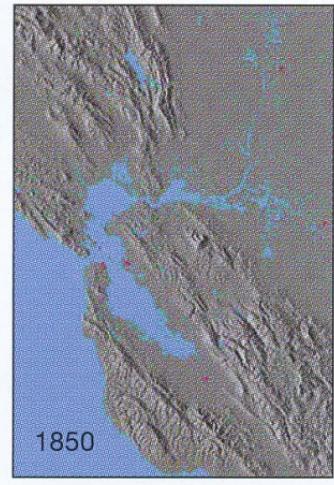
Usefulness of maps...

- ▶ Maps address **key concepts in geography**
 - ▶ Location, scale
 - ▶ Direction
 - ▶ Distance, interaction
 - ▶ Pattern, clustering, association
 - ▶ Regions, change
 - ▶ E.g., climate, weather, population, land-cover maps...
- ▶ Maps help answer questions related to **places, regions, and human-environment interaction**

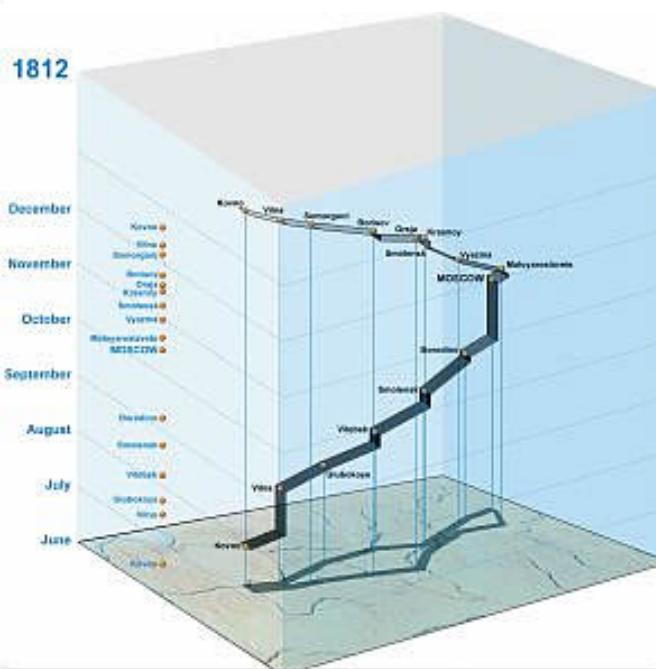
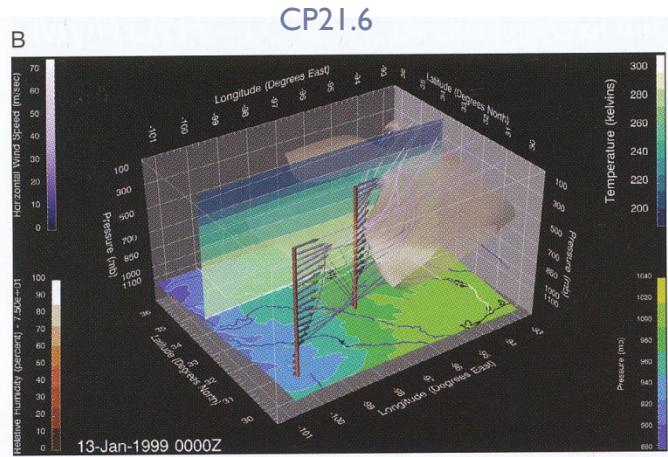


Types of geometric/spatial objects

- ▶ Point: weather stations, bus stops
- ▶ Linear: country, state boundaries
- ▶ Areal: country, state
- ▶ 2.5-D: land surface elevation
(CP21.3), SimCity...
- ▶ True 3-D: atmosphere, ocean
(CP21.6)
- ▶ 4-D Space-time:
weather systems,
migration



CP21.3



- ▶ (source: Slocum et al.; filetraffic.eu;
<http://www.math.yorku.ca/SCS/Gallery/minard/t-3D-napoleon-final.jpg>)

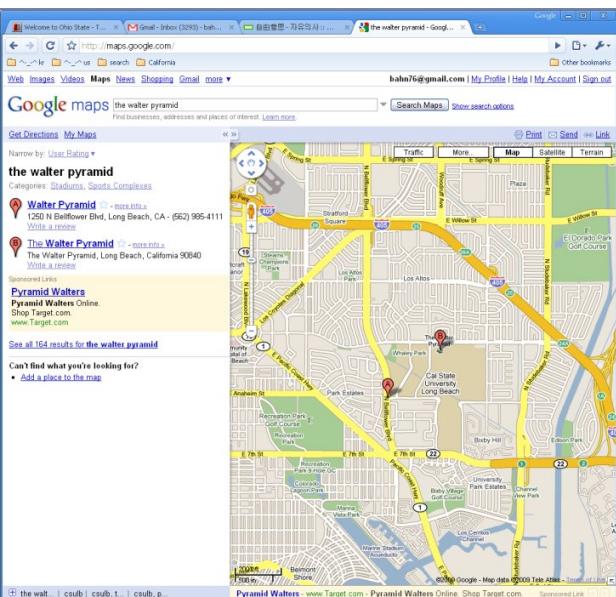
Types of geometric/spatial objects (cont.)

- ▶ Representation is intricately related to **scale of the map**
 - ▶ City (point or area?)
 - ▶ Road (line or area?)
 - ▶ Lake (area or volume?)
 - ▶ River (line, area, volume?)
 - ▶ ...and dimensions?



Spatial dimensionality

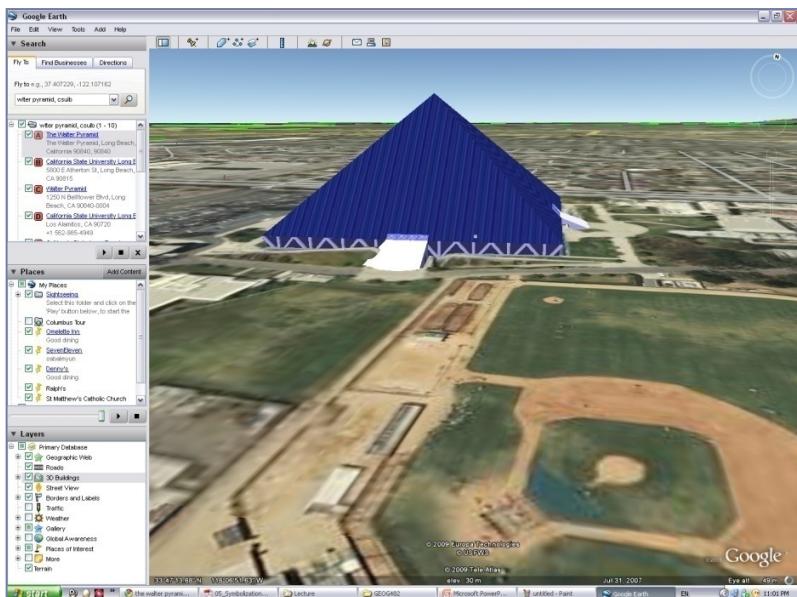
▶ How to represent the Pyramid at CSULB?



Source: Google maps



CSULB Campus Map



Google Earth

The important thing is not to get too hung up on the scheme
but focus on **what to do with your data**

Spatial views of geographic phenomena

- ▶ First, how do we think about space?
 - ▶ Is the world made up of things with a location such as buildings, cities, mountains, or rivers?
 - **The discrete view**

or...

- ▶ Is the world a continuum with measurable attributes at any point such as elevation, moisture, temperature, or vegetation?
 - **The continuous view**



Discrete (object) vs. Continuous (field)

- ▶ Two common ways to represent the world digitally:

Vector (discrete view)

Raster (continuous view)



Welcome to Ohio ... × Gmail - Inbox (329... × 自由意志 - 자유... × the walter pyramid... × Sea Ice in Retreat... × Arctic Sea Ice Ne...

<http://nsidc.org/arcticseainews/>

Other bookmarks

Sea Ice Extent Aug 2009

Total extent = 6.3 million sq km

Figure 1. Arctic sea ice extent for August 2009 was 6.26 million square kilometers (2.42 million square miles). The magenta line shows the 1979 to 2000 median extent for that month. The black cross indicates the geographic North Pole.

[Sea Ice Index data](#). [About the data](#).

Credit: National Snow and Ice Data Center

[High-resolution image](#)

Arctic Sea Ice Extent (Area of ocean with at least 15% sea ice)

Figure 2. The graph above shows daily sea ice extent as of September 7, 2009. The solid light blue line indicates 2009; the dashed lines indicate the range of interannual variability.

Overview of conditions

Sea ice extent averaged over the month of August 2009 was 6.26 million square kilometers (2.42 million square miles). This is 900,000 square kilometers (350,000 square miles) above the record low for the month, which occurred in August 2007, 200,000 square kilometers (77,000 square miles) above August 2008, and just below the August 2005 value of 6.30 million square kilometers (2.43 million square miles). Arctic sea ice extent for August 2009 was 1.41 million square kilometers (540,000 square miles) below the 1979 to 2000 average.

Index Web site.

[Movie of sea ice extent, 1979–2008, in Google Earth](#)

2008 sea ice extent side-by-side with 1979–2008 climatology (QuickTime, 1.6 MB)

[State of the Cryosphere: Sea Ice](#)

[Cryosphere Glossary](#)

[Scientists at NSIDC](#)

Related Resources

NASA Visualization Studio: Arctic Sea Ice 2008

Satellite images and animations: [Daily Arctic Sea Ice Minimum 2008 from SSMI data](#); [2008 Arctic Sea ice from AMSR-E data](#).

Sea Ice Outlook Report

This report, updated monthly during the summer melt season, synthesized scientific projections concerning the September 2008 minimum. From the Study of Environmental Arctic Change.

NOAA Arctic Report Card 2008: Sea Ice

NSIDC Scientist Walt Meier contributed to the sea ice section of the National Oceanic and Atmospheric Association's Arctic Report Card 2008.

earthobservatory.nasa.gov/world-of-change/Sealce

earth observatory

September 2003

March 2004

Sea Ice Concentration (percent)

0 50 100

1999–2000 2016–2017

September 2003 & March 2004

All

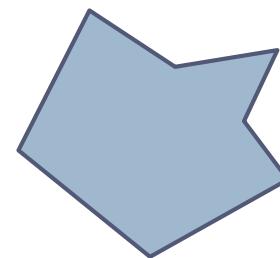
<http://nsidc.org/arcticseainews/>

► Q. Discrete? Continuous?

<https://earthobservatory.nasa.gov/world-of-change/Sealce>

Vector types and objects

- ▶ Applies when a phenomenon can be measured at discrete locations
 - ▶ Points
 - ▶ Cities, trees, houses, archaeological findings...
 - ▶ Lines
 - ▶ Drainage networks, road networks
 - ▶ Areas
 - ▶ Census districts, cities (again), school districts, lakes, land cover units



Continuous fields (raster)

- ▶ Applies when a phenomenon can be measured at all locations
- ▶ Common in physical geography for air pressure, wind speed, elevation etc.
- ▶ 3D-views common to visualize fields
- ▶ Normally represented on a grid – but other representations are used e.g., triangulated irregular networks (TIN) (next)

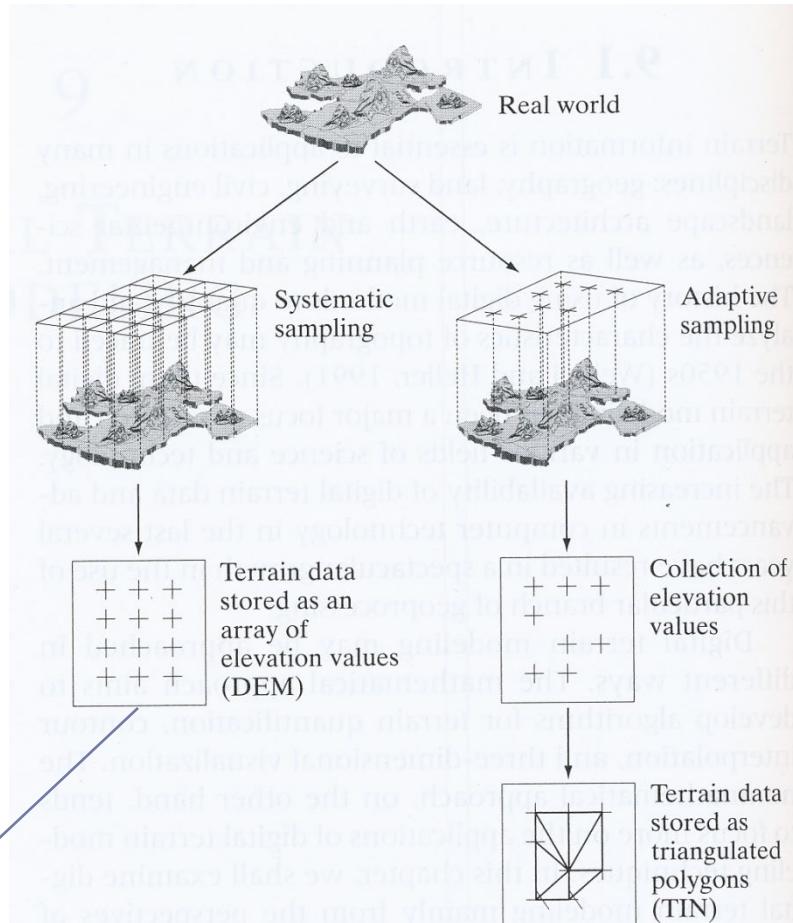
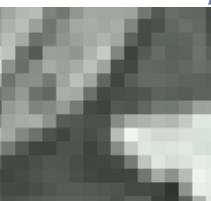


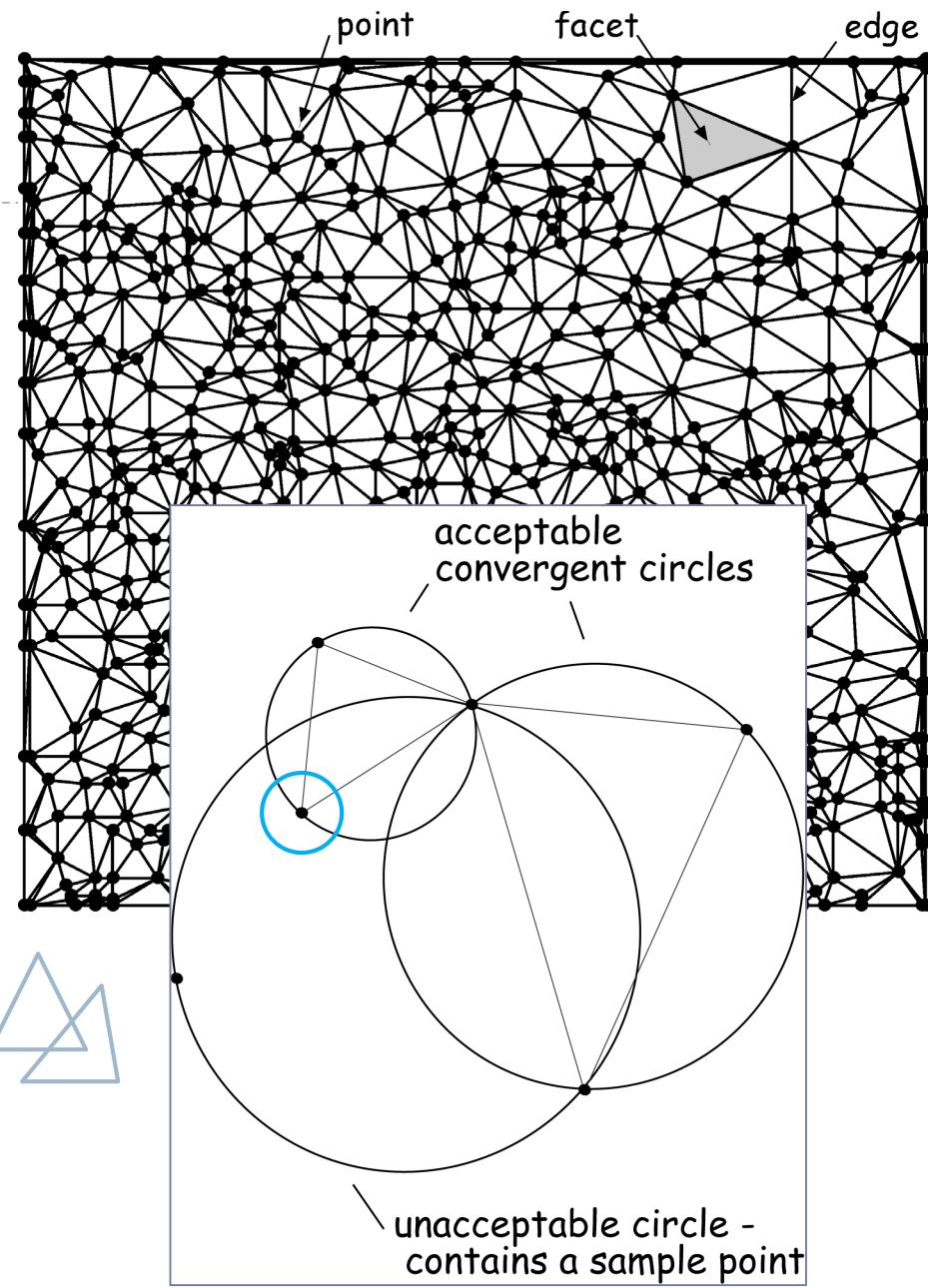
FIGURE 9.2

Approaches to digital terrain data sampling. Terrain data may be sampled either at regularly spaced intervals to form a digital elevation model (DEM) or selectively at salient ground points to form a triangulated irregular network (TIN).

- ▶ (Figure 9.2 in Lo and Yeung, 2007)

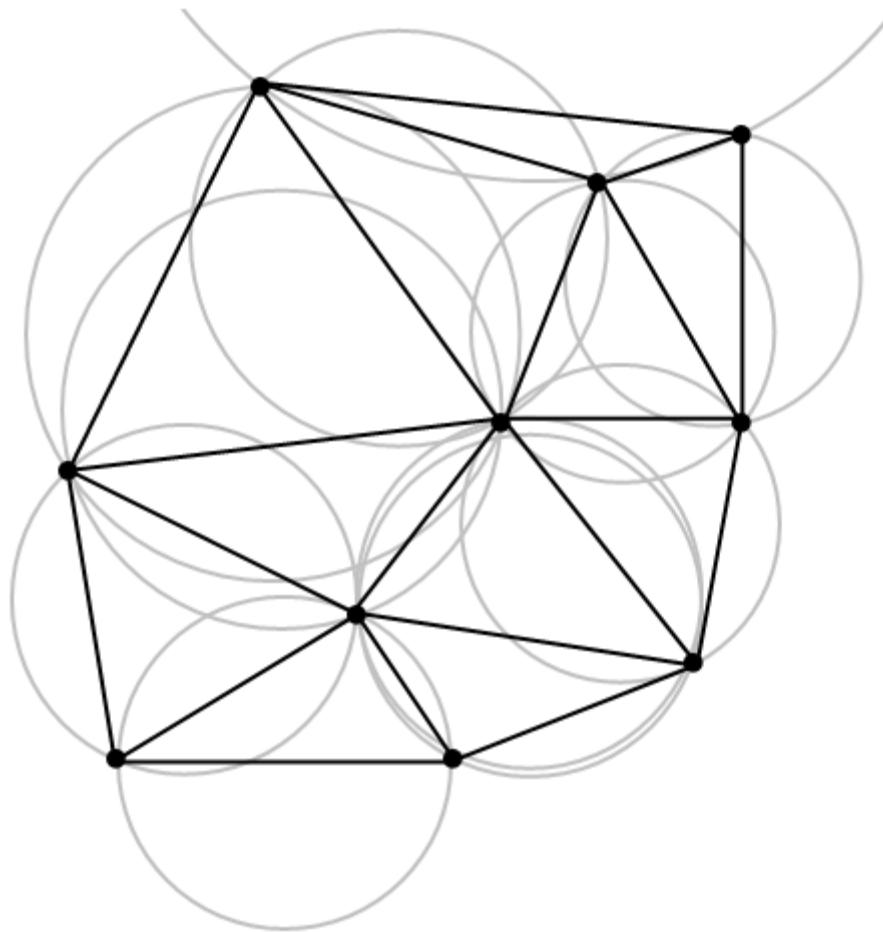
TIN Data Model

- ▶ Frequently used for terrain surface modeling
 - ▶ Slope, aspect, etc.
- ▶ x, y, z coordinates of sample points
- A connected network of triangles
- ▶ **Delaunay Triangle**
 - ▶ Created by lines from one triangle that do not cross the lines of another
 - ▶ A triangle is drawn only if its **convergent circles** contains no other sampling points



(image source: Bolstad, 2012)

Q. Are they Delaunay Triangles?



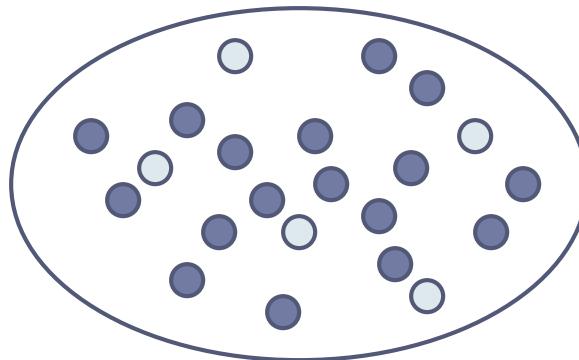
Map data acquisition

- ▶ Sensor (human – machine or combination)
- ▶ Collection protocol
 - ▶ Measure X at certain points using regular intervals
 - ▶ E.g., field work
 - ▶ Identify objects and record locations & attributes
 - ▶ E.g., Remote Sensing
- ▶ Collection method
 - ▶ Field work measurement/observation
 - ▶ E.g., GPS
 - ▶ Remote sensing – interpretation/processing
 - ▶ E.g., Satellite imagery
- ▶ End product
 - ▶ Paper/digital map
 - ▶ GIS database



Samples, population, census...

- ▶ The **population** (or universe) is the **total set** of elements under examination in a study
- ▶ The **sample** is the group of elements actually studied/measured – a **subset** of the population
- ▶ A **census** is a survey where the entire population is studied/measured
- ▶ Usually, we use a sample to say something about the entire population (inferential statistics)



A lot of reasons for sampling

- ▶ Time, cost, and effort
- ▶ Population (all observations) may be **infinite**
 - ▶ E.g., Temperature, elevation, time
- ▶ Population finite but **partly inaccessible**
 - ▶ E.g., Sites with danger
- ▶ Population size and survey technique **tradeoff**
 - ▶ E.g., In-depth interviews of individuals
- ▶ Often not necessary to make a census
 - ▶ Proper samples can be good enough – **with no bias**



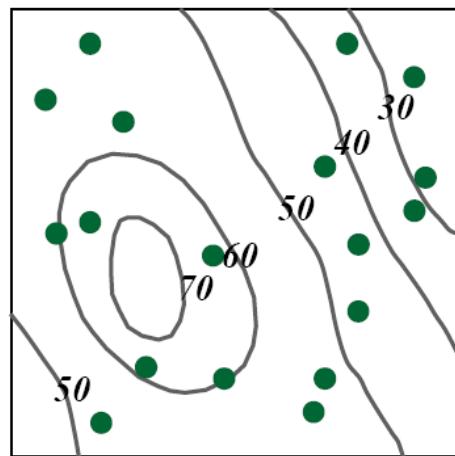
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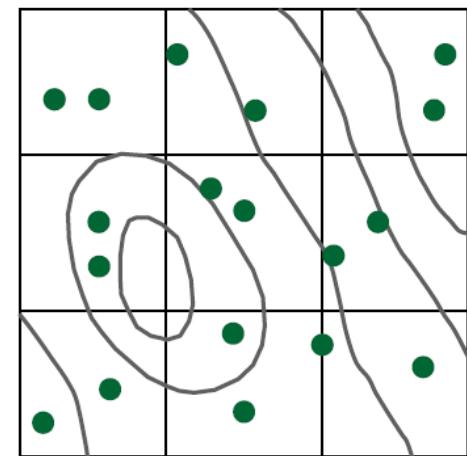
Some common spatial sampling types

1. Simple random
2. Stratified random
3. Random cluster
4. Systematic random
5. Multistage sampling,
combination of 1~4

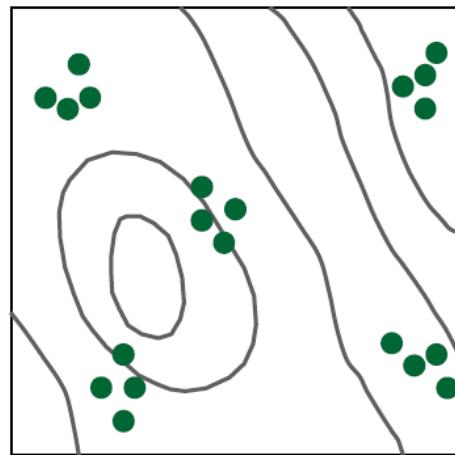
*Example: To measure elevation of the area,
we pick the green dots for sampling...*



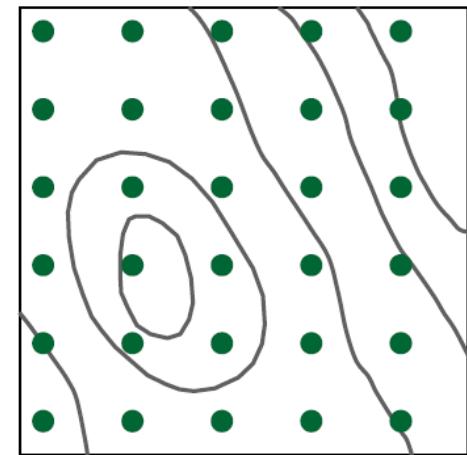
1



2



3

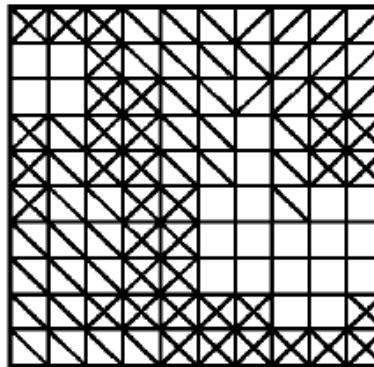
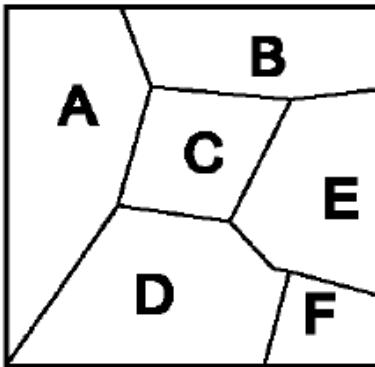
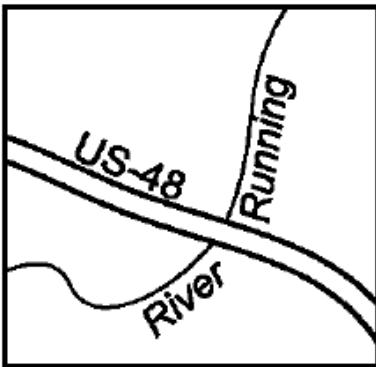
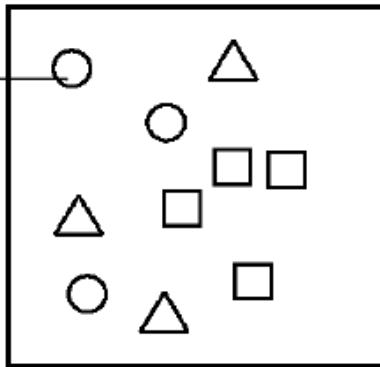


4



Geographic data

- ▶ Typically separated between **geometry** and **attributes** with links



ID	DECLONG	DECLAT	FINALSIZE	AGENCY	DATE_
4384	-114.1833	38.9000	0.10	R4	1989-08-19
1171	-114.3667	39.0000	65.00	NPS	1988-07-07
4377	-114.3167	38.8333	0.30	R4	1989-07-21
1169	-114.2667	39.0167	0.10	NPS	1987-06-28
1178	-114.3000	39.0167	0.10	NPS	1989-10-14
55	-114.2000	39.0330	0.00	BLM	1986-08-06

Relations that link to a map

- ▶ If links are maintained between spatial data (geometry) and attribute data we get a GIS dataset

The diagram illustrates the relationship between a spreadsheet and a GIS application. A black arrow points from the highlighted row in the spreadsheet to the corresponding feature in the GIS map. Another black arrow points from the highlighted row in the GIS attribute table back to the same feature in the map.

provtagningar.xls

	A	B	C	D	E	F	G	H
1	STN	X-koord	Y-koord	Datum	Djup	Temp	pH	Grun
2	88	6544680	1492600	951213	0,5	1,0	7,1	1,4
3	78	6547820	1505310	951213	0,5	0,30	7,3	2,5
4	93	6545650	1510600	951213	0,5	0,9	7,2	2,8
5	113	6538500	1516710	951213	0,5	1,0	7,2	0,7
6	111	6557390	1524680	951213	0,5	0,8	7,3	1,6

MapInfo Professional

Delavr Karta

Delavr Tabell

DELAVR	AREA	PERIMETER
76	392,591	9 396,97
77	3 434,79	39 750,66
78	1 595,28	23 856,71
79	559,524	15 789,54
80	4 854,8	50 444,34
81	2 570,6	31 954,93
82	1 738	22 049,3
83	3 187,03	32 210,85
84	2 576,46	29 764,67
85	896,288	15 352,18
86	836,393	16 172

Where can I find GIS data?

- ▶ U.S. Geological Survey
 - ▶ Geology, Hydrology, Vegetation
- ▶ U.S. Census Bureau
 - ▶ Population, demographics, community statistics
- ▶ U.S. Department of Commerce
 - ▶ economic, business, international trade information
- ▶ U.S. Department of Agriculture
- ▶ U.S. Fish and Wildlife Service
- ▶ Environmental Protection Agency
- ▶ ...and a few other sources



Measurement scales

- ▶ Nominal
 - ▶ Ordinal
 - ▶ Interval
 - ▶ Ratio
- }
- Categorical variables*
- }
- Numerical variables*

- ▶ From an analytical point of view, the most useful measurements are numerical, followed by ordinal, then nominal



Nominal data

- ▶ Categories with no rank or order

- ▶ Examples

- ▶ male/female
- ▶ yes/no/don't know
- ▶ sweet/non-sweet
- ▶ deciduous/coniferous
- ▶ oak/elm/maple
- ▶ land cover/geology
- ▶ hobbit/elf/human/dwarf/ogre/troll



Ordinal data

- ▶ Categories where there is a meaningful way of ranking them, non-numerically

- ▶ Examples
 - ▶ Education: primary/secondary/college
 - ▶ Survey: agree/neutral/disagree
 - ▶ Age classes: young/mid-age/old
 - ▶ Vegetation density: dense/sparse/open
 - ▶ Evaluation: not likely, somewhat likely, likely
 - ▶ Height: troll/elf/human/hobbit



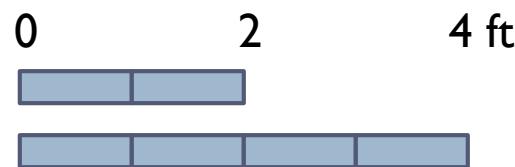
Numeric data

- ▶ Interval: where numbers are associated with data and conceptual distances between them are meaningful, zero is arbitrary

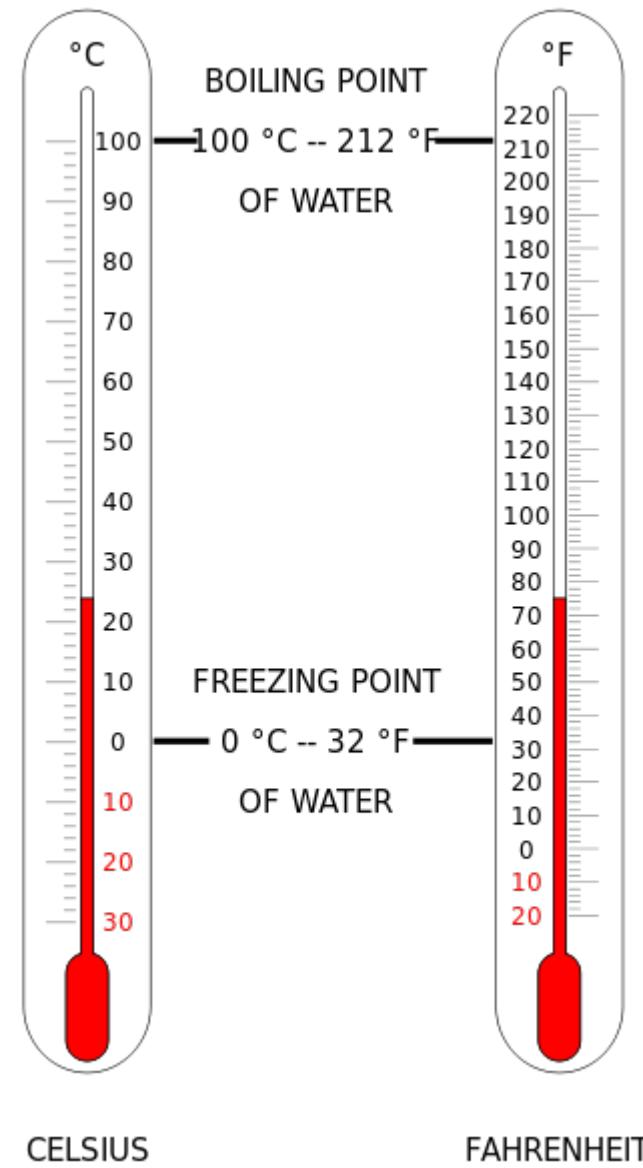
▶ E.g., temperature ($0^{\circ}\text{Celsius} = -273.15\text{ Kelvin}$)

- ▶ Ratio: where ratios are meaningful, or, put another way, zero is not arbitrary but absolute

▶ E.g., length: 2ft & 4ft
(Meters or Feet?)



- ▶ Measurement unit can be arbitrary: ft., mi., in., m, km, cm, ...



Criticism

- ▶ This scheme was developed by Stevens in 1946, and has since been widely taught...
- ▶ It has been criticized, however.
 - ▶ What about...
 - ▶ Angles (*Angle x is as far from 0° as 360°*)
 - ▶ Vectors ($[4,3]$ has same magnitude as $[-3,4]$)
 - ▶ Counts (“11.3 persons” doesn’t make sense.....does it???)
 - ▶ Percentages (typically a bound interval $[0,100]$)
 - ▶ Probabilities (a bound interval $[0,1]$)
 - ▶ Fuzzy ordinal categories (how cool is “cool”?)
 - ▶ Again, the important thing is not to get too hung up on using the scheme, but knowing what to do with your data

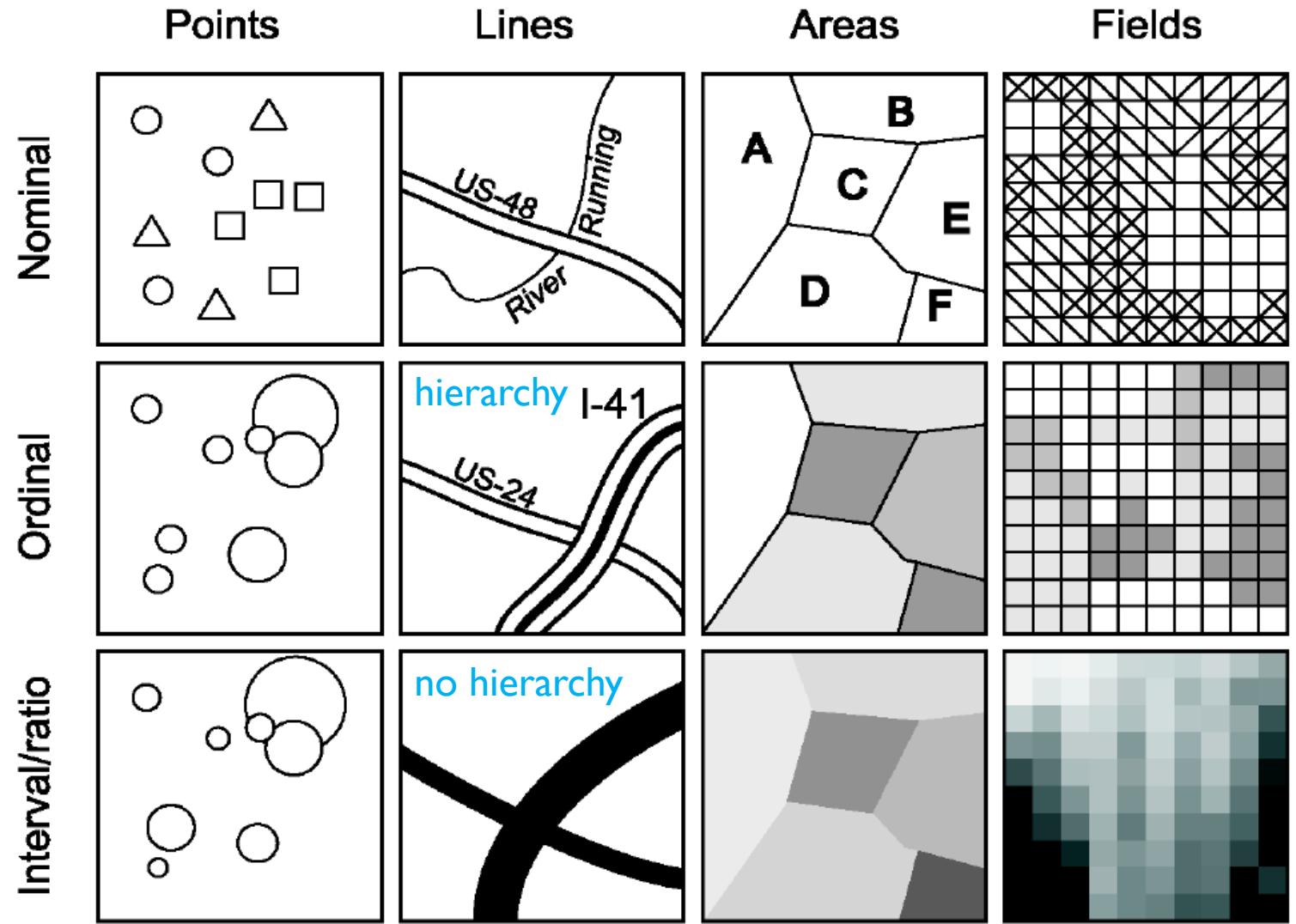


Exercise

- ▶ Make a group of 3-5 people
- ▶ Find 2 examples of nominal, ordinal, interval, and ratio type data
- ▶ Share your group's findings

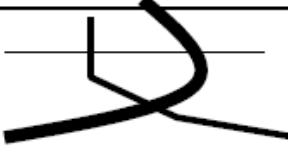
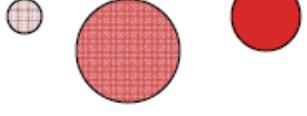
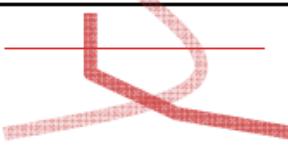
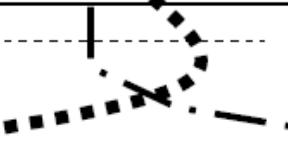
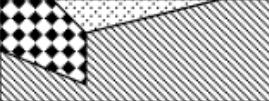


Dimensionality and measurement types combine & require **specific symbolizations**



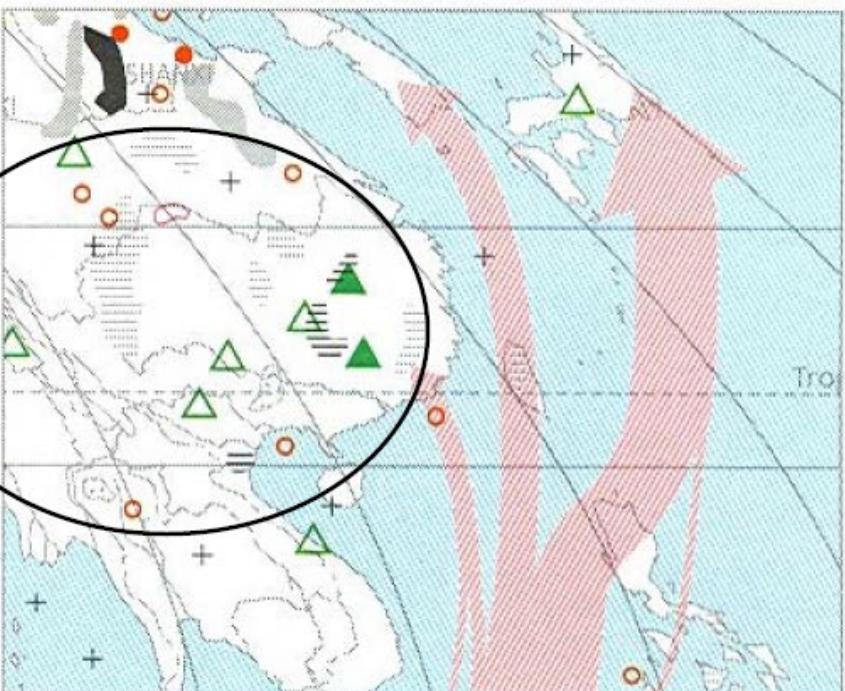
Source: O'Sullivan and Unwin, 2003

Symbolization – the visual variables (see also Color plates 5.1 & 5.2)

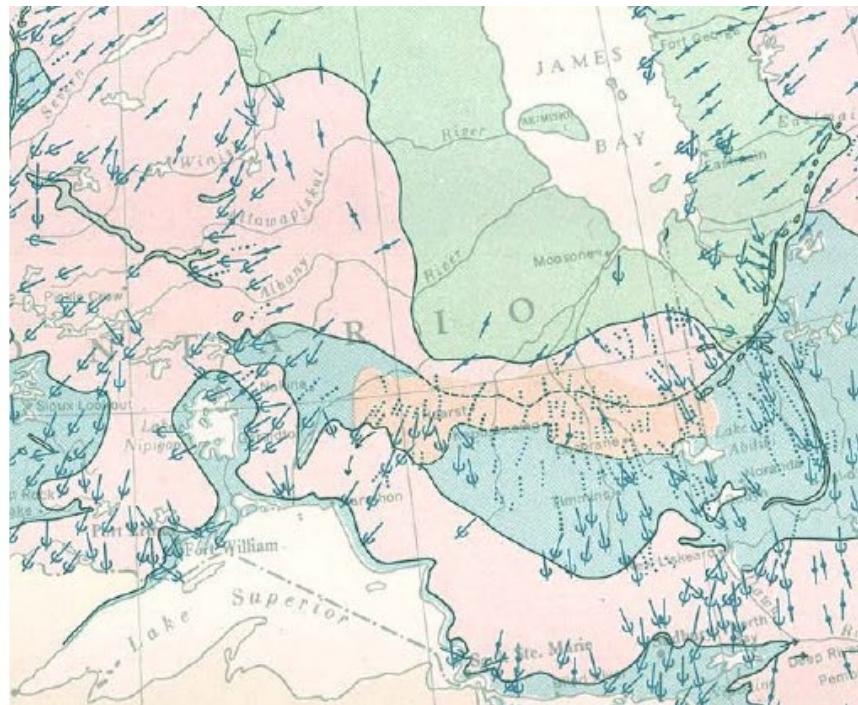
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Shape		Possible but too weird to show	cartogram	Qualitative differences
Size			cartogram	Quantitative differences
Color hue				Qualitative differences
Color lightness				Quantitative differences
Color saturation				Quant. & qual. differences
Texture				Qualitative differences

Shape

	Points	Lines	Areas	Best to show
Shape	■ ▲ □	Possible but too weird to show	cartogram	Qualitative differences

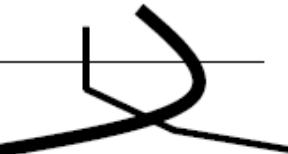


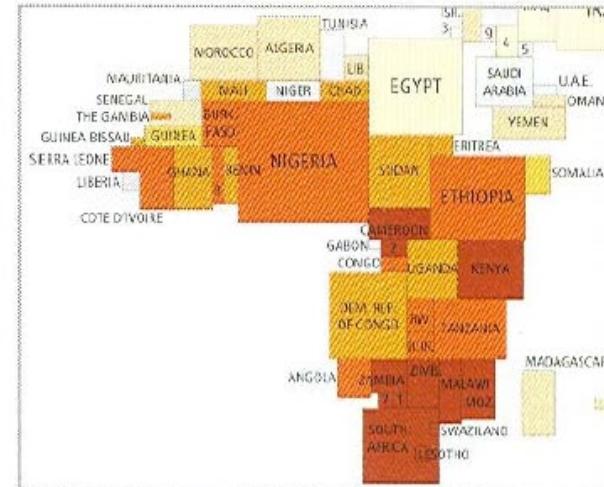
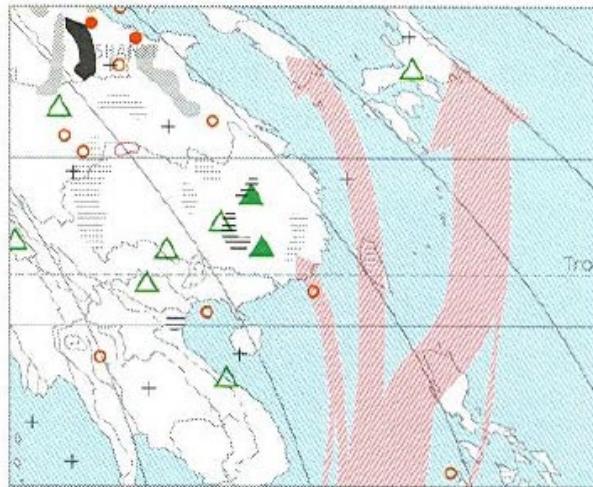
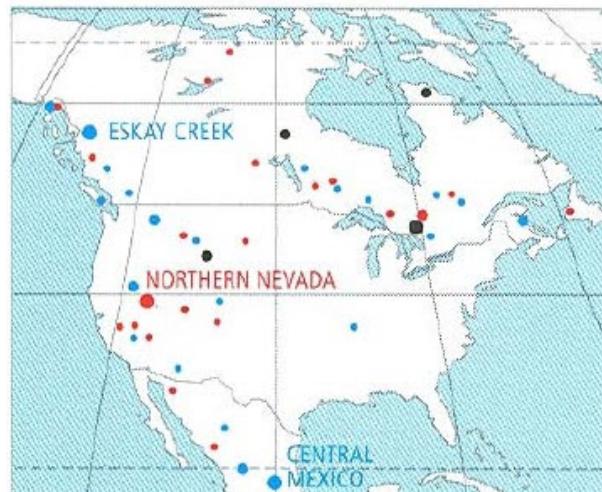
Flow line map: Detail of Mineral Fuels
(pp. 58-59) Source: Goode's Atlas



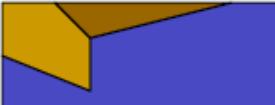
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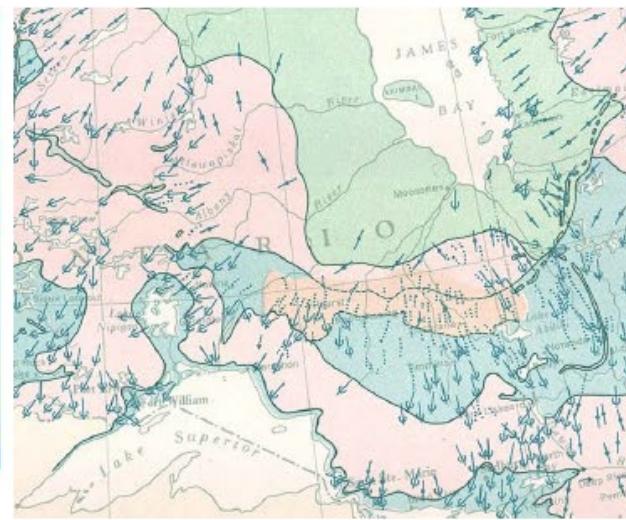
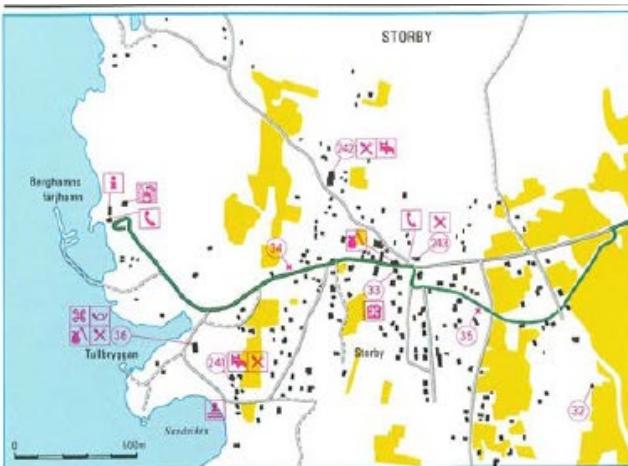
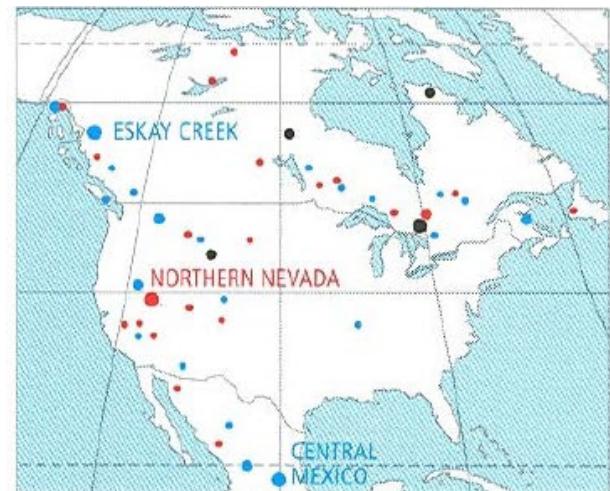
Size

	Points	Lines	Areas	Best to show
Size			cartogram	Quantitative differences



Color hue

	Points	Lines	Areas	Best to show
Color hue				Qualitative differences



Source: Natural Resources Canada

Color lightness

	Points	Lines	Areas	Best to show
Color lightness				Quantitative differences



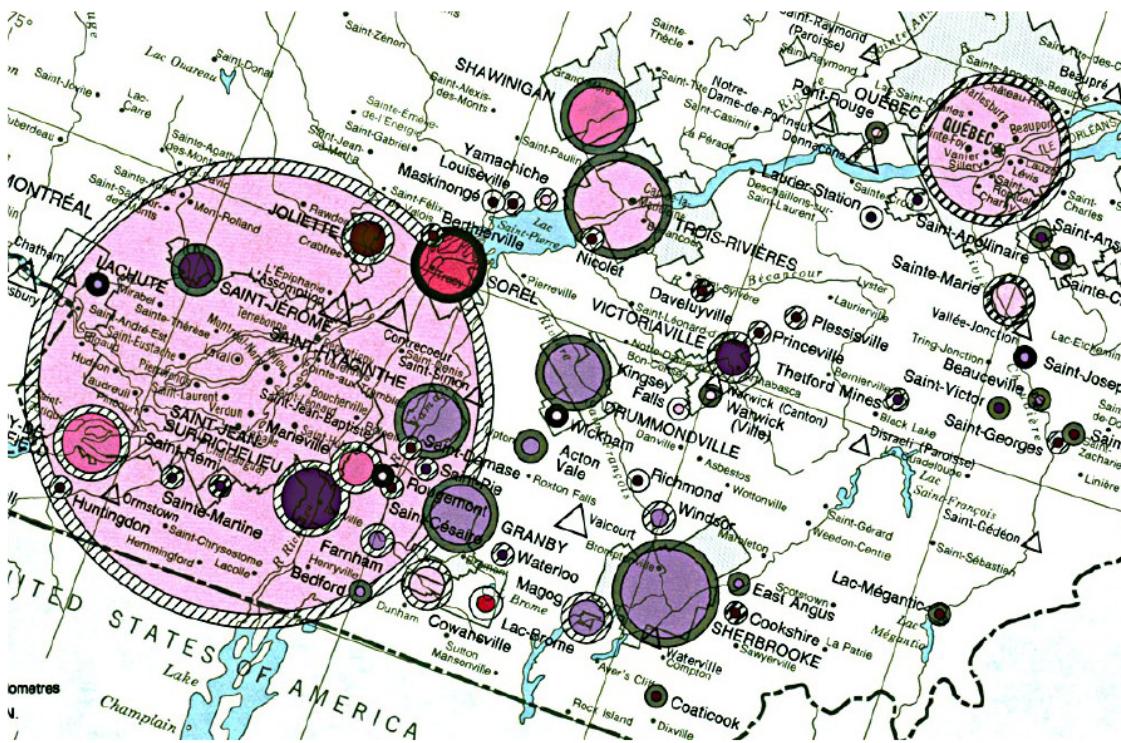
0 100 KM 100 Miles

California Physical Map - California Relief Map

© geology.com

Texture

	Points	Lines	Areas	Best to show
Texture	● ● ●	— — —	■ ■ ■	Qualitative differences



Q. What do you think?
Good texture or not?
Why?

Questions?

- ▶ For next time...
 - ▶ Reading: Ch. I
-
- ▶ Worksheet I



FYI – Certificate Programs in Geography

- ▶ **Certificate in GIS**

- ▶ <http://www.cla.csulb.edu/departments/geography/geographic-information-sciences/>

- ▶ **Certificate in Urban Studies**

- ▶ <http://www.cla.csulb.edu/departments/geography/urban-studies-department-of-geography-csulb/>

